MAINE

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Program Description

Biological monitoring is a primary method used by the State of Maine to assess water quality. The Biological Monitoring Program is one of five Sections within the Division of Environmental Assessment. All field, analytical and statistical methods, including the resultant numeric biocriteria have been designed, developed and tested by the MDEP Biomonitoring Program staff and a consulting biostatistician (Dr. Francis Drummond, University of Maine, Orono, Maine). Water quality standards in current use in Maine, including tiered aquatic life uses and statutory definitions of biological terms, were drafted by the Biomonitoring Program and other staff of the Division of Environmental Assessment.

The State of Maine began the process of biological criteria development by incorporating explicit narrative standards for aquatic life uses in the state water quality classification law. Each of three classes, ranging from "natural" (Class A) to minimum state standards (Class C), contains specific language that defines the allowable biological response, taking into consideration other designated uses, and expectations of community response to human activities allowed in that class. The benthic macroinvertebrate community is assessed to determine attainment of standards.

Maine's numeric biological criteria rely on a three stage decision process. The first stage is a linear discriminant model, utilizing nine metrics to assign an initial classification probability for an unknown site. The second stage linear discriminant model uses 17 additional metrics and indicator taxa, along with probabilities derived in the first stage model, to compute final probabilities of group membership. The output is expressed as a probability of group membership for each of the four water quality classes. The highest class attained, with at least 60% probability, is used as the final model outcome. The third stage uses expert biologist's judgement to make a final decision about attainment, based on the outcome of the linear discriminant analysis, with adjustments for any known sampling errors, unexplained community structure anomalies or atypical conditions surrounding the sampling event.

The regulatory authority for the Department's numeric biological criteria is derived from the tiered aquatic life use designations that are explicitly defined in the water quality standards law (MRSA Title 38 Article 4-A § 464-465). The Department has draft rules in support of the numeric biocriteria protocol and is expected to go to rule-making as soon as a needed electronic database upgrade is completed. The Biological Monitoring Program provides water quality information for a wide array of programs and initiatives including:

- evaluation of water quality classification attainment and 303(d) listing;
- evaluation of impacts downstream of discharges;
- general, long-term ambient monitoring and trend assessment;
- evaluation of the effects of management activities
- evaluation of the effects of nonpoint source impacts;
- evaluation of impacts from diffuse toxic contamination through the Surface Water Ambient Toxics Program (MDEP 1993)
- evaluation of the impacts of hydropower activities in fulfillment of requirements for the Clean Water Act SEC. 401 water quality certification process.

In addition, the Program is refining methods and criteria to better assess aquatic biological impacts of poor land use practices on stream and wetland systems.

MDEP is funded to do a pilot project using the EPA Stressor Identification protocol applied to an intensively surveyed 303(d) listed urban watershed. To facilitate the development of TMDLs, findings from the SI procedure will be used to better target the assessment approach for a set of five other similarly impacted urban streams.

Documentation and Further Information

State of Maine 305(b) Report, Summer 2000

Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams, December 1999: http://www.state.me.us/dep/blwq/docmonitoring/biological/biorep2000.htm

S.P. Davies & L. Tsomides, (1997) "*Methods for Biological Sampling and Analysis of Maine's Inland Waters*", MDEP, revised June 1997: http://www.state.me.us/dep/blwq/docmonitoring/finlmeth.pdf

Relevant biomonitoring materials can be accessed online: http://www.state.me.us/dep/blwq/

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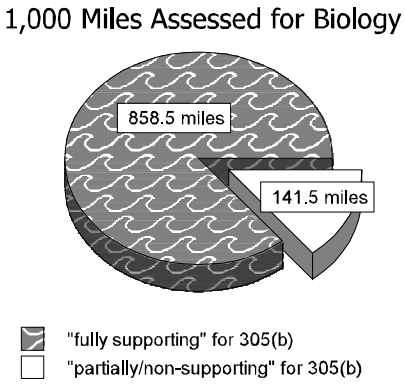
Programmatic Elements

Uses of bioassessment within overall water quality program	✓	problem identification (screening)
	✓	nonpoint source assessments
	✓	monitoring the effectiveness of BMPs
	✓	ALU determinations/ambient monitoring
	✓	promulgated into state water quality standards as biocriteria
	✓	support of antidegradation
	✓	evaluation of discharge permit conditions
	✓	TMDL assessment and monitoring
	✓	other: hydropower dam licensing, uncontrolled hazardous waste site monitoring
Applicable monitoring designs	✓	targeted (i.e., sites selected for specific purpose) *(special projects only)*
	✓	fixed station (i.e., water quality monitoring stations) *(specific river basins or watersheds)*
		probabilistic by stream order/catchment area
		probabilistic by ecoregion, or statewide
	✓	rotating basin *(5 yr rotation, specific river basins or watersheds)*
	✓	other: hydropower dam licensing, uncontrolled hazardous waste site monitoring

Stream Miles

Total miles *(determined using state based local GIS coverage)*	**31,672**
Total perennial miles	23,879
Total miles assessed for biology	**1,000***
fully supporting for 305(b)	858.5
partially/non-supporting for 305(b)	141.5
listed for 303(d)	141.5
number of sites sampled *(on an annual basis)*	40
number of miles assessed per site	~5



*These miles are based on the last five years of monitoring. Stream and river miles are combined, with streams accounting for roughly 80% of the total miles assessed. For program-wide estimation purposes, miles are estimated assuming that each monitored station assesses about 5 miles of river or stream, though this number does vary. The last few years, up to 55 sites have been sampled, but 40 is the average number.

Aquatic Life Use (ALU) Designations and Decision-Making

ALU designation basis		Class system (AA, A, B, C)
ALU designations in state water quality standards*		Four designations based on a gradient of biological condition: AA- "as naturally occurs", natural flow regime; A- "as naturally occurs", hydro allowed; B- "no detrimental change"; C- "maintain structure and function, support for salmonids"
Narrative Biocriteria in WQS		Procedures used to support narrative biocriteria located in MDEP WQS.
Numeric Biocriteria in WQS		under development – Draft numeric biocriteria rule in internal agency review, due for promulgation in 2002. (A probabilistic model - linear discriminant analysis - designed using expert judgment and statistical analysis is currently used to determine attainment of conditions described in aquatic life standards. Numeric biocriteria have been used to implement agency policy since 1990.)
Uses of bioassessment data in integrated assessments with other environmental data (e.g., toxicity testing and chemical specific criteria)	✓	assessment of aquatic resources
	✓	cause and effect determinations
	✓	permitted discharges
	✓	monitoring (e.g., improvements after mitigation)
	✓	watershed based management *(pertains to "small" watersheds)*
Uses of bioassessment/ biocriteria in making management decisions regarding restoration of aquatic resources to a designated ALU		Many examples of this have been documented in case studies provided in "Biomonitoring Retrospective: Fifteen year summary for Maine rivers and streams" available in .pdf on website: http://www.state.me.us/dep/blwq/docmonitoring/biological/biorep2000.htm

*Tiered aquatic life uses in Maine Water Quality standards are consistent with the condition gradient describing other applicable WQ standards (dissolved oxygen, bacteria, toxics) for each class.

Reference Site/Condition Development

Number of reference sites	**370 total**	
Reference site determinations		site-specific
		paired watersheds
	✓	regional (aggregate of sites)
	✓	professional judgment
		other:
Reference site criteria		Minimally disturbed reference site standards are defined by the following criteria – Based on ArcView GIS coverages; by percent of watershed upstream of the sampled station: >90% forested; <5% active logging; <1% cropland, residential or urban.
Characterization of reference sites within a regional context		historical conditions
	✓	least disturbed sites
	✓	gradient response
	✓	professional judgment
	✓	other: minimally disturbed**
Stream stratification within regional reference conditions		ecoregions (or some aggregate)
		elevation
		stream type
	✓	multivariate grouping *(4 multivariate groups)*
		jurisdictional (i.e., statewide)
		other:
Additional information	✓	reference sites linked to ALU
	✓	reference sites/condition referenced in water quality standards *(State of Maine. 1985. Maine Laws Ch. 698 §15 - in part. An Act to Amend the Classification System for Maine Waters)*
	✓	some reference sites represent acceptable human-induced conditions

**Minimally disturbed characterization is one component of established reference conditions; they are also divided into different classes and groups with different biological attributes. Maine has a range of streams, from pristine to severely degraded.

Field and Lab Methods

Assemblages assessed	✓	benthos *(100-500 samples/year; single season, multiple sites - watershed level and broad coverage)*
		fish
	✓	periphyton *(<100 samples/year; single season, multiple sites - broad coverage)*
		other:
Benthos		
sampling gear		rock baskets (500-600 micron mesh)
habitat selection		riffle/run (cobble), artificial substrate
subsample size		entire sample *(if >500 organisms, subsamples are taken proportionately at 25% of sample, then adjusted back to whole sample counts)*
taxonomy		genus, species *(identified to lowest possible level; adjusted to genus in database)*
Periphyton		
sampling gear		**natural substrate**: brushing/scraping device (razor, toothbrush, etc.) **artificial substrate**: periphytometer
habitat selection		open canopy in riffle/run
sample processing		chlorophyll *a*/ phaeophytin; biomass; taxonomic identification
taxonomy		all algae; genus level; species level
Habitat assessments		visual based; performed with bioassessments
Quality assurance program elements		standard operating procedures, quality assurance plan, periodic meetings, training for biologists, sorting proficiency checks, taxonomic proficiency checks, specimen archive

Data Analysis and Interpretation

Data analysis tools and methods	✓	summary tables, illustrative graphs
		parametric ANOVAs
	✓	multivariate analysis
	✓	biological metrics *(multiple computed metrics are used as input variables in probabilistic model)*
	✓	disturbance gradients
		other:
Multivariate thresholds		
defining impairment in a multivariate index		Probabilistic model using *a priori* sites defined by expert judgement
Evaluation of performance characteristics	✓	repeat sampling *(long-term annual monitoring sites)*
	✓	precision *(percent accuracy compared to a priori class)*
		sensitivity
	✓	bias *(in relation to stream size, latitude/longitude, velocity, eco-region)*
	✓	accuracy *(percent accuracy compared to a priori class; a priori reference sites compared to land use - selected reference sites)*
Biological data		
Storage		STORET; Oracle/Visual Basic relational database (with linkage to ARCINFO spatial database with point coverage for all monitoring stations)
Retrieval and analysis		Core linear discriminant models statistical routines are run and reported from within the Oracle database; spatial analysis in ArcView and ARCINFO; routine queries run in MS Access, Systat or Excel